CLAIMS

1. A method for combining two or more risk models to create a risk model with wider scope than its constituent parts. The method insures that the combined risk model is consistent with the component models from which it is formed. The method consists of the following steps:

letting C_1 denote a class of algorithms for constructing estimates of a covariance matrices from time histories of data;

letting C_2 denote a class of asset classes;

for x in C_2 let $C_3(x)$,denoting a class of multi-factor risk models for x;

for y in $C_3(x)$ denoting its parts as follows:

factor exposures $X(y,t)$ at time t;

factor returns $f(y,t)$ at time t; and

specific covariance matrix $D(y,t)$ at time t;

factor covariance matrix $F(y,t)$ at time t;

giving the following components:

two or more asset classes $x_1,\ldots,x_n$,et x denote an asset class which is a union of these given asset classes;

for each asset class x_i giving a risk model y_i in $C_3(x_i)$;

letting $Y(t)$ be such that the decomposition :

$$\underbrace{\begin{pmatrix} f(y_1,t) \\ f(y_2,t) \\ \vdots \\ f(y_N,t) \end{pmatrix}}_{f(t)} = \underbrace{\begin{pmatrix} Y_1(t) \\ Y_2(t) \\ \vdots \\ Y_N(t) \end{pmatrix}}_{Y(t)} g(t) + \underbrace{\begin{pmatrix} \phi_1(t) \\ \phi_2(t) \\ \vdots \\ \phi_3(t) \end{pmatrix}}_{\phi(t)}$$

which results in residuals $\phi(t)$ such that correlation (ϕ_i,ϕ_j) is nearly zero if $i\neq j$; and constructing a risk model for x as follows:

forming $X(t) = diag(X(y_1 , t),\ldots, X(y_n ,t))$;

forming $D(t) = diag(D(y_1, t),...,D(y_n, t))$;

applying a method from C_1 to estimate a covariance matrix $G(t)$ from a history of the $g(t)s$; and

applying an optionally different method from C_1 to estimate a covariance matrix $\Phi(t)$ from a history the $\phi(t)s$;

Then $X(t)[Y(t)G(t)Y(t)^t + \Phi(t)\,\phi(t)]X(t)^t + D(t)$ is a risk model for x.

Insure the risk model is consistent with each component, asset class risk model as follows:

Let $F_1(t)$ be the block diagonal matrix obtained from $Y(t)G(t)Y(t)' + \Phi(t)$ by setting all elements to zero except those of the blocks corresponding to each asset class. Each such block represents the covariance among the factors explaining risk for a particular asset class.

Let $F_2(t)$ be the block diagonal matrix whose blocks contain the asset class factor covariance matrices, $F(y_i, t)$ in the same order as they appear in $F_1(t)$; the off-block diagonal elements are zero.

Given a real symmetric positive semi-definite matrix M, let $M^{\frac{1}{2}}$ denote a square root of M so that $M^{\frac{1}{2}}\left(M^{\frac{1}{2}}\right)' = M$. There may be several choices for $M^{\frac{1}{2}}$. Let $M^{-\frac{1}{2}}$ denote the inverse of $M^{\frac{1}{2}}$, or in the event that the inverse does not exist, let $M^{-\frac{1}{2}}$ be the pseudoinverse.

Then $X(t)\left(F_2^{\frac{1}{2}}F_1^{-\frac{1}{2}}\left(Y(t)G(t)Y(t)' + \Phi(t)\right)\left(F_2^{\frac{1}{2}}F_1^{-\frac{1}{2}}\right)'\right)X(t)'$ is a risk model that is consistent with the component asset class models.

2. A method for combining two or more risk models to create a risk model with wider scope than its constituent parts, comprising the steps of:

denoting a class of algorithms for constructing estimates of a covariance matrices from time histories of data;

denoting a class of asset classes;

denoting a class of multi-factor risk models; and

constructing risk models for each asset class as follows:

applying a method to estimate a covariance matrix from a history; and

combining asset class risk models to form a risk model with broad coverage that is consistent with each asset class model.

3. The method of Claim 2, further comprising the step of:

applying a different method to estimate a covariance matrix from a history.